INDOOR AIR QUALITY ASSESSMENT

Mary A. Dryden Memorial Elementary School
190 Surrey Road
Springfield, Massachusetts

Prepared by:
Massachusetts Department of Public Health
Bureau of Environmental Health Assessment
Emergency Response/Indoor Air Quality Program

July 2003

Background/Introduction

At the request of Judy Dean, Western Massachusetts American Lung Association, the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health Assessment (BEHA), was asked to provide assistance and consultation regarding indoor air quality at the Mary A. Dryden Memorial Elementary School (MDMES), 190 Surrey Road, Springfield, Massachusetts. On March 7, 2003, a visit was made to this school by Michael Feeney, Director of Emergency Response/Indoor Air Quality (ER/IAQ), BEHA, to conduct an indoor air quality assessment. Mr. Feeney was accompanied by Ms. Dean. Reports of inadequate ventilation, odors, lack of temperature control and general indoor air quality complaints prompted the assessment.

The school consists of two separate buildings: the original building and the annex. The original building is a one-story, red brick structure built in 1950s. It contains general classrooms, gymnasium, library, cafeteria and restrooms. Windows are openable throughout the building. The annex is a two room, single story structure and is the subject of a separate report.

Methods

Air tests for carbon dioxide, temperature and relative humidity were taken with the TSI, Q-Trak, IAQ Monitor, Model 8551.

Results

The school complex houses kindergarten through fifth grades with a student population of approximately 350 and a staff of approximately 30. Tests were taken under normal operating conditions and results appear in Table 1.

Discussion

It can be seen from the tables that carbon dioxide levels were above 800 parts per million of air (ppm) in twelve of twenty areas surveyed, indicating inadequate air exchange in most areas of the school. At the time of the assessment, the ventilation system was deactivated, which would limit the introduction of fresh air and contribute to elevated carbon dioxide levels.

Fresh air in classrooms is supplied by a unit ventilator (univent) system (see Picture 1). Univents are designed to draw air from outdoors through a fresh air intake located on the exterior wall of the building and return air through an air intake located at the base of each unit (see Figure 1). Fresh and return air are mixed, filtered, heated and provided to classrooms through a fresh air diffuser located on the front of the unit. As discussed, univents were found deactivated, preventing a continuous source of outside air. Obstructions to airflow into fresh air intakes by shrubbery were also noted (see Picture 2). In order for univents to provide fresh air as designed, univent air intakes, diffusers and return vents must remain free of obstructions. Importantly, these units must be activated and allowed to operate.

Exhaust ventilation grilles are located in the ceiling of coat closets. Air is drawn into the coat closet from the classroom via undercut closet doors (see Picture 3). The location of these closet vents allows them to be easily blocked by stored materials. As with the univents, in order to function properly, exhaust vents must remain free of obstructions.

To maximize air exchange, the BEHA recommends that both supply and exhaust ventilation operate continuously during periods of school occupancy. In order to have proper ventilation with a mechanical supply and exhaust system, the systems must be balanced to provide an adequate amount of fresh air to the interior of a room while removing stale air from the room. The date of the last servicing and balancing was not available at the time of the assessment. It is recommended that existing ventilation systems be re-balanced every five years to ensure adequate air systems function (SMACNA, 1994).

The Massachusetts Building Code requires a minimum ventilation rate of 15 cubic feet per minute (cfm) per occupant of fresh outside air or have openable windows in each room (SBBRS, 1997; BOCA, 1993). The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this happens a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health

Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week, based on a time-weighted average (OSHA, 1997).

The Department of Public Health uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches. For more information concerning carbon dioxide, please see Appendix I.

Temperature readings ranged from 71° F to 79° F, which were very close to the BEHA recommended comfort guidelines. The BEHA recommends that indoor air temperatures be maintained in a range of 70° F to 78° F in order to provide for the comfort of building occupants. Temperature control is difficult without ventilation systems operating as designed. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply.

Relative humidity in classrooms was measured in a range of 12 to 30 percent. The BEHA recommends a comfort range of 40 to 60 percent for indoor air relative humidity. The sensation of dryness and irritation is common in a low relative humidity environment. Humidity is more difficult to control during the winter heating season. Low relative humidity is a very common problem during the heating season in the northeastern part of the United States.

Microbial/Moisture Concerns

Shrubbery in direct contact with the exterior wall brick was noted along the front of the building (see Pictures 2, 4 and 5). Shrubbery directly against the building can serve as a possible source of water impingement on the exterior curtain. Plants retain water and in some cases can work their way into mortar and brickwork causing cracks and fissures, which may subsequently lead to water penetration and possible mold growth. Over time, this process can undermine the integrity of the building envelope and provide a means of water entry into the building through capillary action via foundation concrete and masonry (Lstiburek & Brennan, 2001).

Several pathways exist for crawlspace air to migrate into occupied areas. A crawlspace exists under classrooms to provide a chaseway for univent heating pipes. The interiors of univents were randomly examined. Spaces and holes in walls and floors around pipes and within the air handling cabinet were observed (see Pictures 6 & 7). Please note that holes also exist in the rear wall of univents that open into the exterior wall system. These breaches can serve as pathways to draw air, odors and particulates from exterior wall cavities and the crawlspace into classrooms. Crawlspace access hatches located in classroom floors also provide potential pathways (see Picture 8). The seals around hatches appeared damaged. Heated air from HVAC system pipes can create drafts that rise from the crawlspace into classrooms around hatchways. These drafts can also draw mold, spores and associated odors from the crawlspace.

Plants were noted in several classrooms, and in one instance a planters had been placed on top of the univent. Plants can be a source of pollen and mold, which can be respiratory irritants for some individuals. Plants should be properly maintained and equipped with drip pans. Plants should also be located away from univents to prevent the aerosolization of dirt, pollen or mold (see also Picture 2, shrubbery in front of outside air intake).

Several classrooms have sinks that have a seam between the countertop and wall. Water penetration through this seam can result if not watertight. Water penetration and chronic moisture exposure can cause porous materials to swell and serve as a growth medium for mold.

Other Concerns

Several other conditions that can potentially affect indoor air quality were alsoidentified. The kitchen contains a natural gas fueled oven (see Picture 9). According to the Massachusetts Building Code, "[s]tationary local sources producing airborne particulates, heat, odors, fumes, spray, vapors, smoke or gases in such quantity as to be irritating or injurious to health shall be provided with an exhaust system or means of collection and removal of contaminants" (SBBRS, 1997; BOCA, 1993). The vent to the oven was deactivated. Deactivation of the vent allows for products of combustion related to burning natural gas as well as products produced from heating/cooking food to accumulate in the kitchen, cafeteria and surrounding hallways. The process of combustion produces a number of pollutants, depending on the composition of the material. In general, common combustion emissions can include carbon monoxide, carbon dioxide, water vapor and smoke. Operation of the oven hood is essential to removing these pollutants from the indoor environment.

Several converted classrooms/offices are located around an unused shower room. The floor in the shower room is equipped with floor drains. Since the showers are not used, it is likely that these drains have dry traps, which can allow sewer gas to back up into occupied areas. Sewer gas can be irritating to the eyes and nose.

Cleaning products were found on countertops and in unlocked storage cabinets beneath sinks in a number of classrooms. Cleaning products contain chemicals, which can be irritating to the eyes, nose and throat and should be stored properly and kept out of reach of students.

Also of note was the amount of materials stored inside classrooms. In classrooms throughout the school, items were observed on windowsills, tabletops, counters, bookcases and desks. The large number of items stored in classrooms provides for dusts to accumulate. These items, (e.g. papers, folders, boxes, etc.) make it difficult for custodial staff to clean. Dust can be irritating to eyes, nose and respiratory tract. Items should be relocated and/or be cleaned periodically to avoid excessive dust build up.

In an effort to reduce noise from sliding chairs, tennis balls are sliced open and placed on chair legs. Tennis balls are made of a number of materials that are a source of respiratory irritants. Constant wearing of tennis balls can produce fibers and to off-gas VOCs. Tennis balls are made with a natural rubber latex bladder, which becomes abraded when used as a chair leg pad. Use of tennis balls in this manner may introduce latex dust into the school environment. Some individuals are highly allergic to latex (e.g., spina bifida patients) (SBAA, 2001). It is recommended that the use of materials containing latex be limited in buildings to reduce the likelihood of symptoms in sensitive individuals (NIOSH, 1997). A question and answer sheet concerning latex allergy is attached as Appendix II (NIOSH, 1998).

Conclusions/Recommendations

The conditions noted at the MDES raise a number of issues. These, in concert with the design of the building and the condition of the ventilation system can adversely influence indoor air quality. In view of the findings at the time of the visit, the following recommendations are made:

1. Seal all holes in the walls of the univent air handling cabinets to limit filter bypass. Double sided, foil faced insulation with adhesive can be applied in a manner to create an airtight seal.
2. Seal walls in the rear of each univent cabinet and floor holes to prevent air draw from the exterior wall cavity and crawlspace, respectively. Seal the seams and holes in crawlspace access hatches with duct tape.
3. For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. To control for dusts, a high efficiency particulate arrestance (HEPA) filter equipped vacuum cleaner in conjunction with wet wiping of all surfaces is recommended. Avoid the use of feather dusters. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations).

4. Seal areas around sinks to prevent water-damage to the interior of cabinets and adjacent wallboard. Inspect adjacent areas for water-damage and mold growth, repair/replace as necessary. Disinfect areas of microbial growth with an appropriate antimicrobial as needed.
5. Remove plants from tops of univents. Ensure plants have drip pans. Examine drip pans periodically for mold growth and disinfect with an appropriate antimicrobial where necessary. Remove foliage to no less than five feet from the foundation/exterior walls.
6. Discontinue the use of tennis balls on chairs to prevent latex dust/allergen generation.
7. Relocate or consider reducing the amount of materials stored in classrooms to allow for more thorough cleaning. Clean items regularly with a wet cloth or sponge to prevent excessive dust build-up.
8. Consider sealing drains in unused shower room. It not sealed, ensure that water is poured into each drain twice a week (or more frequently if needed) to maintain the trap.
9. In order to maintain a good indoor air quality environment within the building, consideration should be give to adopting the US EPA document, "Tools for Schools", which can be downloaded from the Internet at http://www.epa.gov/iaq/schools/index.html.
10. For further building-wide evaluations and advice on maintaining public buildings, see the resource manual and other related indoor air quality documents located on the MDPH's website at http://www.state.ma.us/dph/beha/iaq/iaqhome.htm.

References

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Picture 1

Univent

Picture 2

Shrubbery Obstructing Univent Fresh Air Intake

Picture 3

Exhaust Vent in Closet with Undercut Doors

Picture 4

Shrubbery in Direct Contact with the Exterior Wall Brick Was Noted Along the Front of the Building

Picture 5

Shrubbery in Direct Contact with the Exterior Wall Brick Was Noted Along the Front of the Building

Picture 6

Holes within the Air Handling Cabinet

Picture 7

Holes Exist in the Floor for the Univent Heating Pipes

Picture 8

Crawlspace Access Hatches Located In Classroom Floors

Picture 9

The Kitchen Contains A Natural Gas Fueled Oven

TABLE 1

Indoor Air Test Results –Mary Dryden Elementary School – Springfield, MA   March 7, 2003

Location	Carbon Dioxide *ppm	Temp °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Supply	Exhaust	
Outdoors (Background)	381	35	22					
Room 18	1179	79	18	4	Y	N	N	Window open
Room 5	692	71	15	0	Y	Y	Y	WD sink, door/window open Supply/exhaust ½ blowing
Room 6	1106	72	19	17	Y	Y	Y	WD sink Supply/exhaust ½ blowing
Room 3	959	72	17	1	Y	Y	Y	WD sink, door open Supply/exhaust ½ blowing
Room 4	970	73	17	20	Y	Y	Y	WD sink, crawl space, door open Supply/exhaust ½ blowing
Room 1	1321	74	19	22	Y	Y	Y	Lysol Supply/exhaust ½ blowing
Room 2	1417	73	24	21	Y	Y	Y	Plant cleaner, door open Supply/exhaust ½ blowing
Nurses Office	1263	73	25	5	Y	N	N	Radiator
Cafeteria	1233	73	30	4	Y	N	Y	Exhaust - kitchen hood Door open
Gym	842	72	23	22	N	Y	Y	

*** ppm = parts per million parts of air**
½ = 1 out of 2 blowing

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

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Location	Carbon Dioxide *ppm	Temp °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Supply	Exhaust	
Room 12	769	74	18	21	Y	Y	Y	WD sink Exhaust off, supply ½ blowing
K-1	642	75	15	15	Y	Y	Y	Supply½ blowing Exhaust ½ off, door open
Room 11	647	74	16	10	Y	Y	Y	WD sink Door open
Library	729	75	15	14	Y	Y	Y	Exhaust covered by shelf – off Supply ½ blowing, window open
Room 10	962	75	18	24	Y	Y	Y	Exhaust off Supply ½ blowing
Room 17	737	77	17	2	Y	Y	Y	Supply off
K – 2	1142	75	18	3	Y	Y	Y	WD sink Exhaust off
Room 15	496	74	12	9	Y	Y	Y	Window open
Room 9	602	76	16	2	Y	Y	Y	Exhaust off, plant over supply vent Door open
Room 8	750	76	16	22	Y	Y	Y	Exhaust off WD sink

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